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### Nursing students' attitudes towards information communication technology

**Citation for published version:**

Lee, JJ & Clarke, C 2015, 'Nursing students' attitudes towards information communication technology: An exploratory and confirmatory factor analytic approach' *Journal of Advanced Nursing*, vol. 71, no. 5, pp. 1181–1193. DOI: 10.1111/jan.12611

**Digital Object Identifier (DOI):**

[10.1111/jan.12611](https://doi.org/10.1111/jan.12611)

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Peer reviewed version

**Published In:**

*Journal of Advanced Nursing*

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- **Title:** Nursing students' attitudes towards information communication technology: An exploratory and confirmatory factor analytic approach
- **Running head:** Nursing students' attitudes towards information communication technology
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- **Acknowledgements:** The authors thank Mr. Rod Ward (University of the West of England) who allowed using and modifying the ITASH. Furthermore, the authors also appreciate Dr Karen McKenzie, Dr Maggie Carson, Dr Colin Chandler (University of Edinburgh) and Mr. Jongwon Yoo (University of Illinois at Chicago), for their feedback during the drafting of this paper.
- **Conflict of Interest statement:** No
- **Funding Statement:** No

## **Abstract**

**Aim:** The aim of this study was to develop and psychometrically test a shortened version of the Information Technology Attitude Scales for Health, in the investigation of nursing students with clinical placement experiences.

**Background:** Nurses and nursing students need to develop high levels of competency in information and communication technology. However, they encounter significant barriers in the use of the technology. Although some instruments have been developed to measure factors that influence nurses' attitudes towards technology, the validity is questionable and few studies have been developed to test the attitudes of nursing students, in particular.

**Design:** A cross-sectional survey design was performed.

**Methods:** The Information Technology Attitude Scales for Health was used to collect data from October 2012 to December 2012. A panel of experts reviewed the content of the instrument and a pilot study was conducted. Following this, a total of 508 nursing students, who were engaged in clinical placements, were recruited from six universities in South Korea. Exploratory and confirmatory factor analyses were performed and reliability and construct validity were assessed.

**Results:** The resulting instrument consisted of 19 items across four factors. Reliability of the four factors was acceptable and the validity was supported.

**Conclusions:** The instrument was shown to be both valid and reliable for measuring nursing students' attitudes towards technology, thus aiding in the current understandings of this aspect. Through these measurements and understandings, nursing educators and students are able to be more reflexive of their attitudes and can thus seek to develop them positively.

**Key words**

Attitudes toward technology, confirmatory factor analysis, exploratory factor analysis, computer competency, instrument development, nursing informatics, nursing research

**Summary Statement****Why is this research or review needed?**

Nurses and nursing students are required to be competent in the use of information and communication technology, but their competencies are questionable.

Although some instruments measuring nursing professionals' attitudes towards information and communication technology have been introduced, the validity is questionable.

Many studies in the nursing field have employed factor analysis with ordinal data, but few studies have used empirical evidence for ordinal data type.

**What are the key findings?**

Nursing students' attitudes towards information and communication technology can be easily and quickly captured using the shortened instrument tested in this research; its reliability and validity was confirmed.

This research demonstrated similarities and differences in nursing students' attitudes towards information and communication technology with existing instruments measuring the attitudes.

Factor analysis strategies, based on empirical evidence, such as parallel analysis, polychoric correlation and ordinal coefficient alpha, though rarely used in nursing studies, were adopted in this study.

### **How should the findings be used to influence policy/practice/research/education?**

The development of a valid and reliable instrument will enhance nurses' and nursing educators' understanding of nursing students' attitudes towards information and communication technology in clinical contexts.

In evaluating nursing students' attitudes towards information and communication technology, nursing educators can design and provide appropriate nursing education, which considers the use of the technology for the students.

This research provides an example of factor analysis based on empirical evidence for ordinal data type to inform future uses of this analytical method.

## INTRODUCTION

Information and Communication Technology (ICT) has greatly impacted many parts of the world and has worked to change peoples' daily lives, through providing faster and more convenient communication, easier acquisition of information and its ability to provide better quality of life. It is noteworthy that ICT, in particular, benefits healthcare systems. Technology has enabled health related professionals, in many countries, to manage large amounts of data and has improved the effectiveness of work flow; these benefits are reflected in enhanced levels of patient safety and satisfaction by reducing medical errors (e.g. medication and communication errors) (McGonigle & Mastrian 2009, Parente & McCullough 2009). The importance of ICT in clinical contexts amongst nursing professionals cannot be overemphasised, thus necessitating their competence in ICT. However, previous research found that there are significant barriers for nurses using ICT, such as their lack of ICT experience, confidence, competency and education (Gilmour *et al.* 2008, Chang *et al.* 2011). In an attempt to understand and search for resolution of these identified barriers, some instruments have been developed (primarily in the United States) that are used to measure factors that influence nursing professionals' ICT related attitudes and competencies (Chang *et al.* 2011). However, nursing professionals continue to experience a lack of ICT competency and there is much debate as to whether the instruments are truly reliable and/or valid (Jayasuriya & Caputi 1996, Ward *et al.* 2008, Wilkinson *et al.* 2009). Nursing students should be also proficient in ICT, as they work in the same clinical contexts with nurses during clinical placements, which enable them to learn nursing practices (McDowell & Ma 2007). Thus, it is necessary to develop instruments, which enable the investigation of competencies and attitudes towards ICT of nursing students, who have worked and are currently working in clinical

placements. However, limited research has broached this issue, ascertaining nursing students' attitudes towards ICT and most of the existing attitude instruments have been developed for registered nurses.

## **Background**

Insofar as ICT devices have been widely adopted in healthcare fields, it is important to pay them adequate attention. However, Stronge and Brodt (1985) argued that the influence of user factors should not be underestimated and ignored. Similarly, many serious problems such as medical errors can arise when health professionals only focus on the devices themselves, without considering users' aspects in the application of ICT in clinical environments (Stronge & Brodt 1985, Ward *et al.* 2008). Thus, human factors, such as attitudes towards ICT should be explored and quantified with reliable and valid instruments.

A comprehensive literature review was conducted using the databases CINAHL Plus, PubMed and Medline, with four key words: nursing, attitudes, technology and instrument. Although many studies ascertaining nursing professionals' attitudes towards ICT have been conducted, few instruments were identified that have been developed for their use in the field of nursing, specifically.

Nurses' Attitudes Toward Computerization (NATC), developed by Stronge and Brodt (1985), is one of these popular instruments. A pilot study with 48 nursing students identified 20 items stemming from six major issues: job security, legal ramifications, quality of patient care, capabilities of computers, employee willingness to use computers and benefits to the institution.

The study computed a split-half reliability coefficient as  $r = 0.90$  (Stronge & Brodt 1985). Follow-up studies adopting the NATC instrument, such as Schwirian *et al.* (1989), Scarpa *et al.* (1992) and Stockton and Verhey (1995), used larger and different sample sizes, yet reported disparate results, with variations in the naming and/or numbers of factors.

Another commonly used tool is the Nurses Computer Attitudes Inventory (NCATT), developed by Jayasuriya and Caputi (1996). Items in NCATT were derived from a panel review and a comprehensive literature review. They collected data from both nursing students and nurses and identified 22 items and three factors: 'computers and patient care', 'computer anxiety' and 'patient confidentiality and computers', using an exploratory factor analysis (EFA). NCATT demonstrated adequate overall reliability (Cronbach's  $\alpha = 0.95$ ) and concurrent validity, using the Computer Attitude Scale, developed by Dambrot *et al.* (1985).

Another study by Sinclair and Gardner (1999), drawing on the Computer Attitude Scale, developed by Loyd and Gressard, (1984), was conducted using nursing student participants. This study extracted three factors: 'confidence in using computers', 'motivation to use computers' and 'perceived career-related importance of computers', with 19 items by EFA and achieved satisfactory reliability for each factor (Cronbach's  $\alpha = 0.90, 0.81$  and  $0.75$ , respectively). However, the validity of this instrument was not reported.

These tools, discussed above, measuring attitudes towards technology in nursing fields were developed in the 1990s. However, healthcare technology has developed rapidly and new clinical environments have emerged with more contemporary and complex technologies. Therefore, the tools used in the 1990s are unlikely to be appropriate for use in the current era.

More recently, Maag (2006) performed a national survey in the United States with the aim of



identifying nursing students' attitudes towards technology, using the Technology Attitude Scale (TAS), developed by McFarlane *et al.* (1997). Maag used EFA to identify two factors, 'confidence in and the benefits of using technology' and 'lack of self-efficacy in the use of technology', with 15 items. The instrument reported acceptable overall reliability (Cronbach's  $\alpha=0.89$ ). However, Maag (2006) did not report the validity of this research.

In the same year, the Information Technology Attitude Scales for Health (ITASH) was developed for assessing health professionals' attitudes towards ICT, particularly nurses' attitudes in the United Kingdom (Ward *et al.* 2006). Ward *et al.* (2006) identified 71 statements from relevant literature, which were then analysed using EFA, wherein 48 items were grouped into three factors, namely 'efficiency of care', 'education, training and development' and 'control'. The reliability of each factor was assessed as Cronbach's  $\alpha=0.88$ , 0.70 and 0.83, respectively. Concurrent validity of each factor was also evaluated. For 'efficiency of care', concurrent validity was investigated using a comparison with the NATC scale (Stronge & Brodt 1985). The validity of the other two factors was ensured through further qualitative interviews with participants.

To summarise, the measurement of nurses' and nursing students' attitudes towards ICT is vital, but it remains difficult to identify factors underpinning attitudes, as many of the current studies have indicated that attitudes towards ICT is often associated with diverse and complex factorial structures (Ward *et al.* 2008). Although some of the instruments reported their validity, many did not and thus the controversy surrounding their validity still remains; this issue should be addressed, as ensuring clear validity is essential for developing effective instruments (DeVon *et al.* 2007).

## **THE STUDY**

### **Aim**

The aim of this study was to develop and psychometrically test the shortened version of ITASH by investigating nursing students in South Korea, with clinical placement experience, by using the techniques of EFA and confirmatory factor analysis (CFA).

### **Methodology**

A cross-sectional study was designed to develop the shortened version of ITASH and to test its validity and reliability. The instrument development process was conducted in two phases: The first phase assessed the content validity, included a pilot study and facilitated the translation of the instrument from English into Korean; the second phase tested and validated the instrument developed in the first phase, using factor analysis.

### **Participants**

This research recruited nursing students as its participants.

The original ITASH recruited qualified nurses as its participating subjects, thus it follows that the suitability of the instrument be assessed for nursing students. To this end, four third-year nursing students at a university in the UK, who had experienced clinical placements, were invited to

review the instrument in a pilot study. These pilot study participants were all British, although two of them were Korean-born migrants. The Korean-born migrant participants played two important roles, 1) examining the suitability of the instrument and 2) accounting for cultural differences that may arise in administering the instrument to Korean students.

In the second phase, two convenience sample groups of nursing students from Seoul, South Korea were generated; the first were recruited from three universities for EFA (423 participants) and the second, from three different universities for CFA (234 participants). The recruited nursing students all met the following inclusion criteria: 1) nursing students who were studying at the end of third or fourth year in a four-year nursing baccalaureate program in Seoul, South Korea and 2) nursing students who had experienced placement in a clinical setting. The exclusion criterion included those registered nurses currently in a program to earn a bachelor's degree. To ensure consistency, one researcher (JLL) visited all six universities and asked nursing students for their participation in this research, providing an explanation of the purposes of the research. The data were collected from October 2012 to December 2012. Paper-based ITASH questionnaires were used as a way to eliminate the biases of internet-based questionnaires, as it was assumed that internet-based questionnaires could influence responses of attitudes towards technology. After collecting data, those questionnaires with over five uncompleted items were excluded. In total, 346 and 162 participants were selected for EFA and CFA analysis, with a response rate of 82% and 69%, respectively.

### **Instrument of ITASH**

This study adopted the instrument, ITASH, because it met the following criteria: 1) developed in

nursing fields after 2000, 2) dealt with ICT in clinical contexts and 3) assured reliability and validity. Other instruments, such as those containing factors related to electronic medical records or those that did not report validity or only assured content validity were not considered in this study.

For this research, permission to use and modify the ITASH was granted by Rod Ward, the main developer of ITASH.

#### *Step I: Reviewing ITASH contents*

All 48 items in ITASH were investigated for content validity by a panel of experts, including two senior educators in the healthcare field and one nursing researcher in the ICT profession. Four items (Q36, Q38, Q43 and Q45) that were not relevant to ICT, were initially eliminated by the panel. Furthermore, some words in the ITASH questionnaire were slightly modified (e.g., 'computers' was replaced with 'ICT devices'), in order to ensure more accurate and precise meanings. This modified ITASH using 44 of the 48 original items employed a four-point Likert scale (1 = strongly disagree to 4 = strongly agree) and also included demographic questions. After modifying the ITASH, its contents were reviewed in a pilot study by four nursing students, as was mentioned above. All four participants confirmed the applicability of the instrument for nursing students.

#### *Step II: Translation*

Following confirmation of the tests applicability, the instrument, originally written in English, was translated into Korean. Two professional translators, one nurse and one nursing student both bilingual and fluent in English and Korean were involved in this process. Both the nurse and the nursing student were involved as a way to ensure the semantic aspect of the translation within a clinical context. The process of translation in this study is shown below, in Figure 1.

### **Ethical considerations**

Ethical approval for this research was obtained from the researcher's institutional review board. The approval letter was sent to six nursing schools in Seoul, and the schools subsequently granted permission for data collection to take place. Students were fully informed of the study on the first page of the questionnaire, wherein their participation was clearly described as voluntary and their rights such as confidentiality and withdrawal were assured. Implied consent to participate was acknowledged by the completion and returning of the questionnaire.

### **Data analysis**

Statistical analysis on the data collected from the ITASH was undertaken for factor analysis using SPSS version 19 with R-Factor (V2.2.1) for EFA and LISREL version 8.8 for CFA. Prior to the analysis, responses to negative questions were reverse coded. As the correlation matrix plays a critical role in both EFA and CFA, the determination of a correlation method was prudent. Pearson correlation is one of the popular statistical techniques in social sciences, however this correlation is more suitable for continuous as opposed to ordinal data (Holgado-Tello *et al.* 2010,

Basto & Pereira 2012). Unlike the Pearson correlation, polychoric correlation is a statistical method which enables the estimated correlation of ordinal variables (Lee *et al.* 2012). Thus, polychoric correlation is a suitable technique to estimate the association between ordinal variables and was thus adopted in this study over the Pearson correlation. EFA was implemented in four phases:

#### *1) Estimation of sample size and sampling adequacy*

An appropriate estimation of a sample size is vital not only for reliable and valid results, but also with regards to ethicality (Gaskin & Happell 2014). Kline (1986) asserted that 100 or more participants is a preferable sample size. Furthermore, a minimum of five participants per variable is said to be acceptable (Hair *et al.* 2010).

Bartlett's test of sphericity was employed in this study as a way to identify sampling adequacy for factorability (Hair *et al.* 2010). Assuming the hypothesis is not rejected, the sampling would be deemed unfit for EFA. The adequacy was also measured using the Kaiser-Meyer-Olkin (KMO) test, wherein if the value of KMO is the same or higher than 0.50, the sampling adequacy is considered to be acceptable (Kaiser & Rice 1974).

#### *2) Determination of the number of factors to retain*

During the EFA process, the determination of the number of factors to retain is more vital than the determination of extraction and rotation methods (Zwick & Velicer 1986). Horn's parallel analysis (PA) and Velicer's minimum average partial (MAP) are frequently recommended for the determination as the best empirical evidence (Zwick & Velicer 1986, Ruscio & Roche 2012). When PA is used with ordinal data, Garrido *et al.* (2012) stress that PA with polychoric

correlation generates more accurate results than the Pearson correlation. Schmitt (2011) reported that MAP is one of the most accurate methods and the combination of PA and MAP is strongly recommended, as it outperforms other methods. The current research calculated these two analyses, PA and MAP, to determine the number of factors to retain.

### *3) Decision of a factor extraction and rotation method*

A suitable extraction method, which fits the purpose of its specific research objectives and methodology should be carefully implemented (Gaskin & Happell 2014). The extraction method employed is determined based on the type of data collected (e.g., interval, nominal and ordinal) (Gaskin & Happell 2014). This research used the minimum residuals (MNRES) extraction method. This was decided due to the fact that MNRES is deemed an appropriate extraction method for ordinal data (as identified in a literature review undertaken by Gaskin and Happell (2014)). The oblique rotation, particularly the oblimin rotation was also adopted in this research, as oblique rotation methods assume that correlations between factors exist (Polit 2010). This was further justified in that it was assumed there would be some identifiable correlations between the extracted factors, as there typically exist at least some correlations within psychological and educational research (Schmitt 2011).

### *4) Refinement of the factor structure and items*

Factor loadings were considered in this research in order to verify the appropriate variables of each factor (Polit 2010), as the higher loading variables in each factor ultimately determines the essence of the factor (Hair *et al.* 2010, Polit 2010). Factor loadings of variables with values of 0.40 and above are considered to be satisfactory (Hair *et al.* 2010). Internal consistency reliability was also examined. Ordinal coefficient  $\alpha$ , developed by Zumbo *et al.* (2007) in their

simulation study, was adopted for testing internal consistency reliability of each factor, as it is more accurate for estimating the reliability with ordinal data than Cronbach's  $\alpha$  (Zumbo *et al.* 2007, Liu *et al.* 2010). The ordinal coefficient  $\alpha$  is conceptually the same as Cronbach's  $\alpha$ , but the ordinal one is based on polychoric correlation (Basto & Pereira 2012, Gadermann *et al.* 2012). The  $\alpha$  value of 0.70 or higher was considered to be reliable in this research. Following statistical analyses, item contents in the extracted factors were reinvestigated by the panel for theoretical consistency of the contents in the each factor.

CFA followed EFA in order to verify whether the hypothesised structure from EFA was consistent and valid. The sample size for CFA was estimated. Over five times the number of variables are considered to be acceptable (Kääriäinen *et al.* 2011) and the sample size for CFA should be at least, if not over, 150 samples (Anderson & Gerbing 1988). This research used ordinal data, thus LISREL 8.8 was employed since it supports polychoric correlation. A number of estimations have been proposed in the literature for testing the fit between the factor structure and data. This study adopted the most popular fit indices of CFA, including the chi-square statistic, Root Mean square Residual (RMR), Root Mean Square Error of Approximation (RMSEA), Goodness-of-Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), the Normal Fit Index (NFI), Incremental Fit Index (IFI) and the Comparative Fit Index (CFI). In the chi-square statistic, a p-value of 0.05 and above represents the goodness of fit. Moreover, the normed chi-square is achieved by dividing a chi-square value by its degrees of freedom (df) and a range between 0 and 3 is considered acceptable, while a lesser value is more preferable (Child 2006, Hair *et al.* 2010). Values for the GFI, AGFI, NFI and CFI range between 0 to 1 and the values over 0.90 and preferably 0.95 or higher are considered a reasonable model of fit (Hu & Bentler 1999, Child 2006, Hair *et al.* 2010). When a sample size is under 250, as is the case in this study,



and the number of variables range between 12 and 30, RMR and RMSEA of 0.08 or less are considered evidence for a reasonable fit (Hair *et al.* 2010).

## **RESULTS**

### **Socio-demographic characteristics**

Among the EFA samples of 346 students, the mean age was 23.65 years (SD = 2.70), ranging from 21 to 43 years, where 93.9% were female compared to 6.1% males and the number of third- and fourth-year students were 43.9% and 56.1%, respectively. In comparison to EFA, the mean age of the CFA sample (n = 162) was 23.15 years (SD = 1.73), ranging from 21 to 34 years and the gender ratio was 98.1% female and 1.9% male; furthermore, 56.6% were third-year and 43.4% were fourth-year students (see Table 1).

### **Factor Structure of the shortened version of ITASH**

#### *Exploratory factor analysis*

The participants-to-variable ratio was 7.86:1, indicating that the sample size of this study was appropriate for factor analysis. The KMO measure was 0.75 and Bartlett's test of sphericity was significant ( $\chi^2 = 3986.35$ , df = 210 and  $P < 0.001$ ). Thus, the sampling adequacy was satisfactory for factor analysis.

During three attempts of EFA, the items with factor loadings lower than 0.40 or cross-loadings on other factors with over 0.40 factor loadings were removed in the sorted pattern matrix.

Furthermore, a factor with less than a 0.70 ordinal coefficient  $\alpha$  was eliminated (Munro 2005). As a result, a total of 18 items were omitted and a four-factor-structure with 26 items was confirmed through the statistical process of EFA. Following this process, the factors and items were reviewed by a panel. During this review process, the contents of grouped items within each factor were carefully examined for content consistency. Subsequently, five items in Factor 3 and 4 (as presented in Table 2) were removed, due to a lack of consistency with the other items in the factors. The accepted 21 items, with four factors from EFA, is shown in Table 3.

### *Interpretation*

Given the four factors derived from EFA, an interpretation focusing on higher factor loading items of each factor and its comparison to the original ITASH, was performed by the panel. Factor 1 was labelled 'care value of ICT', as it consisted of four items dealing with the topic of care values through ICT. The second factor, consisting of six items, was called 'training of ICT skills', as the contents dealt with ICT training for developing relevant skills. Factor 3 was made up of six items that captured elements of confidence of ICT, therefore, the title of this factor was 'ICT confidence'. Lastly, five items in Factor 4 included aspects with regards to ICT influences on workloads and was thus labelled 'workload value of ICT'. The titles of each of the four factors describe the conceptual domain: 'care value of ICT' that is a subscale measuring how nursing students regard the contribution of ICT towards care; 'training of ICT skills,' which investigates the attitudes of nursing students towards their ICT training and their desire for further ICT training; 'ICT confidence,' a subscale assessing nursing students' confidence in dealing with ICT; and the subscale, 'workload value of ICT' that examines their attitudes towards work efficiency in using ICT.

### *Confirmatory factor analysis*

With the defined factors and variables provided from EFA, CFA was performed (see Figure 2). Hair *et al.* (2010) asserted that CFA with unidimensionality of each factor must be confirmed as the unidimensionality determines the suitability as to whether variables are acceptable for each factor or not. Accordingly, all four factors' unidimensionality was supported in this research and the results of the fit indices are shown in Table 4. The fit indices of Factor 1, 2 and 4 demonstrated excellent fit values. The normed chi-square values were less than 3.0 and chi-square associated p-values were higher than 0.05. Moreover, the GFI, AGFI, NFI, IFI and CFI were equal to, or higher than 0.98 and all the values of RMR and RMSEA were lower than 0.06. Factor 3, however, indicated unsatisfactory fit results in the chi-square associated p-value and in the RMSEA value, although other indices in Factor 3 were acceptable. For this reason, Factor 3 was modified by removing two items (Q19 and Q47). After the elimination of these two items, fit indices in Factor 3 were significantly improved and demonstrated excellent fit. Overall fit indices of the Korean ITASH were also tested after examining the unidimensionality of each factor. All indices with 19 items presented reasonable fits.

According to the responses from participants of EFA and CFA, more positive attitudes were realised towards the care value of ICT and training of ICT skills, than attitudes towards the ICT confidence and the workload value of ICT, as is shown in Table 5.

### **Validity and Reliability**

Construct validity was evaluated through convergent and discriminant validity with CFA samples. The values of construct reliability (CR) and the average variance extracted (AVE) were computed for the convergent and discriminant validity, respectively. The CR value should be equal or higher than 0.70 to ensure the convergent validity and internal consistency (Hair *et al.* 2010). Furthermore, the square of the correlation between two factors should not exceed the AVE values for discriminant validity (Hair *et al.* 2010). As is presented in Table 6, all CR values of the factors exceeded 0.70, ranging from 0.84 to 0.91. Moreover, none of the squared correlations surpassed any AVE values in this study. Thus, convergent and discriminant validity of the four factors were supported. All four factors' ordinal coefficient values with CFA samples were also computed and ranged between 0.81 and 0.90. Therefore, the internal consistency reliability was supported.

## **DISCUSSION**

### **Discussion of results**

The overall aim of this study was to develop and test a shortened version of ITASH and assess its reliability and validity from a new dataset, generated using empirical methods. This study verified that the shortened version of ITASH is a valid and reliable instrument to investigate attitudes towards ICT for nursing students who have clinical placement experiences.

The original ITASH reported three factors with 48 items (Ward *et al.* 2006), however this study verified four factors with 19 items. The factor of efficiency of care in the original ITASH was subdivided into two factors, the care value of ICT and the workload value of ICT. Such a

division was justified insofar as nursing students may feel that work and care values are separate issues, whereas qualified nurses, in the original ITASH, may view the two values as indistinguishable. The other two factors in this research matched the original version of ITASH. Despite the fact the current study reported different labels of factors, the conceptual factor structure is similar to that of the original ITASH. In comparison with factor structures of other instruments, three of the four factors in this research have been identified as being similar to factors in other instruments. Many instruments, such as those implemented by Jayasuriya and Caputi (1996), Scarpa *et al.* (1992) and Sinclair and Gardner (1999), identified factors related to care and work values. The factor, ICT confidence was also addressed in other research, such as in Maag (2006) and Sinclair and Gardner (1999). However, it is challenging to find instruments that deal with nursing professionals' attitudes towards training of ICT skills as a core factor. It was reported, among many studies, that the factor related to ICT education had a significant influence upon nursing professionals' ICT attitudes (Chan *et al.* 2004, Lee 2005). However, these findings have rarely been reflected on in the development of instruments that measure attitudes within nursing fields. In particular, because ICT training impacts the use of ICT for care (Wilkinson *et al.* 2009), it is vital that nursing professionals and educators assess attitudes towards ICT training and this can be measured through implementing the shortened version of ITASH.

This study also aimed to develop a shortened version of ITASH. A shortened version of an instrument is more appealing and feasible to respondents than is an instrument containing an overwhelming number of questions (Bradburn *et al.* 2004). Moreover in instances when a questionnaire is too long, respondents may feel fatigue, thus resulting in less accuracy. Consequently, the development of a shortened instrument is preferable (Fanning 2005). Item reductions can be achieved by factor analysis (Hair *et al.* 2010). However, insofar as this

research removed 29 items from the initial ITASH, through multiple stages of analysis, it became more crucial for this research to carefully verify the reliability and validity of the new version of ITASH (Hair *et al.* 2010). Moreover, it is a prerequisite of all research developing and employing instruments to confirm the validity and reliability of their use, to increase confidence in the research findings (DeVon *et al.* 2007). Through various statistical analytic strategies, this research confirmed that all 19 items had the appropriate factor loadings and that each factor demonstrated excellent fit to the items with secured reliability and validity.

Adapting the original ITASH, which assessed attitudes of qualified nurses, to the attitudes held of student nurses raises some important issues. Currently, a limited number of studies investigate ICT attitudes of nursing students with experience in clinical placements. Furthermore, it was merely assumed that ITASH was also acceptable for nursing students, insofar as they share clinical contexts with qualified nurses during their clinical placements, yet such an assumption should not be made so rashly. As a result, this research only considered nursing students who have had clinical placement experiences and the content validity was further examined by nursing educators and nursing students.

This research used PA and Velicer's MAP to determine the number of factors to retain and employed MNRES extraction with oblimin rotation based on the polychoric correlation, given that this study generated ordinal data. From a methodological standpoint of factor analysis, several issues were treated carefully in this research. Many factor analysis studies in nursing fields have relied on conventional and popular methodological strategies, such as PCA extraction with varimax rotation and a Pearson correlation matrix, providing little rationale for their selection (Gaskin & Happell 2014). However, researchers should be more cautious when

selecting strategies, such as extraction, rotation and correlation methods in factor analysis, as these are significantly influenced by data types (e.g., ordinal data and interval data), and inappropriate selection can lead to notably different research findings. Meanwhile, some researchers claim that PCA and EFA often draw similar results (Polit 2010), yet even in cases where similar findings can be produced from different strategies, this does not imply that researchers are free to select whichever method they prefer. Rather, it is necessary, during factor analysis, that researchers should be aware of the differences and select the most suitable strategies for connecting the aims of their research to a logical rationale, as these selections act as a parameter of which to judge the quality of research (Holgado-Tello *et al.* 2010).

## **Study limitations**

This study has several limitations. Firstly, this study was conducted in Seoul and used a convenience sample. The results of this study may thus not be generalised to other nursing students studying in other regions of South Korea or in other countries. Secondly, there was a limitation regarding whether or not sufficient factors with influence on nursing students' attitudes towards ICT were included. Although this study attempted to accept diverse conceptualisations of attitudes, it did not cover all aspects of attitudes, which are currently being proposed in the research field, such as age, gender and confidential issues (Ward *et al.* 2008).

## **CONCLUSION**

The accurate measurement of nursing students' attitudes towards ICT in clinical settings through the use of a reliable and valid instrument is crucial for understanding attitudes, as ICT has become an important tool for nursing practice and is continuously developing. The results of this research suggest that attitudes towards ICT can be easily and quickly captured using the shortened version of ITASH, which proved to be both reliable and valid. Therefore, it is recommended that the shortened ITASH be used to evaluate nursing students' attitudes towards ICT. The findings using the shortened ITASH can enhance nursing educators' awareness of attitudes, allowing them to carefully reflect upon these in their developments of the education plans for students. Moreover, insofar as students are able to assess their own attitudes, they can seek to positively develop their ICT competencies. Nonetheless, there are some limitations of this research and it is recommended that researchers test the shortened ITASH in different contexts with different samples, as well as conduct more research on attitudes towards ICT in order to identify other factors, which can strongly influence nursing practices and the healthcare industry as a whole.



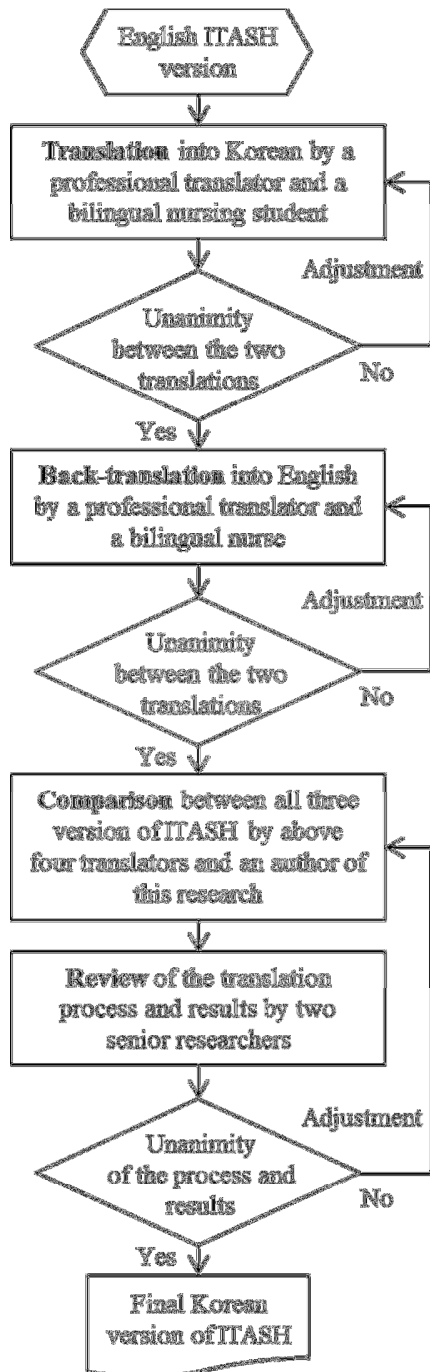
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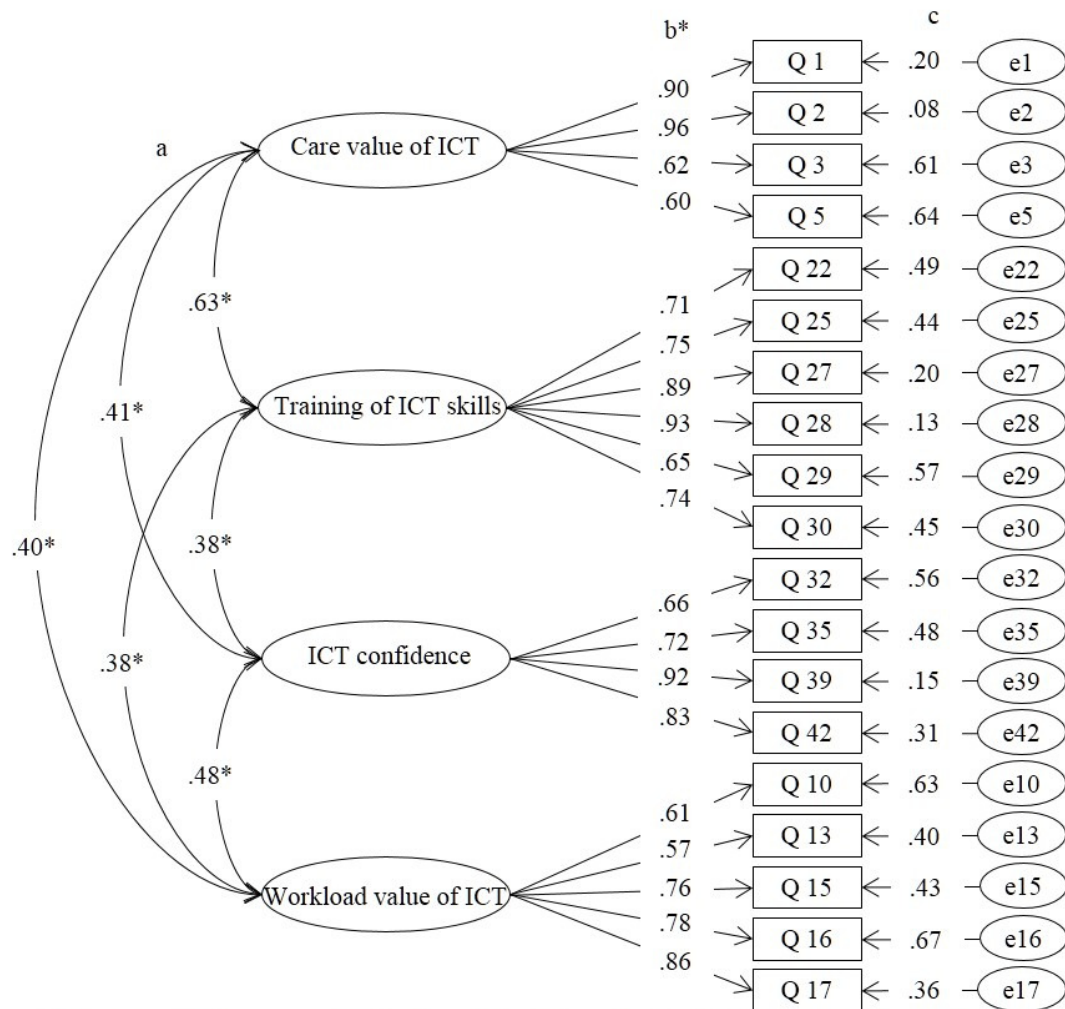
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**Figure 1** Translation process of the Information Technology Attitude Scales for Health (ITASH)



**Figure 2** Factor structure of the Korean version of Information Technology Attitude Scale for Health with correlations among four factors, standardised factor loadings and error terms



Note: 'a' = correlations among the scales; 'b' = standardised factor loadings; and 'c' = error terms; \* =  $p < 0.01$

**Table 1** Demographic data

	EFA (n=346)	CFA (n=162)
Gender		
Female	325	159
Male	21	3
Year of education		
Third	152	90
Fourth	194	72
Age	21-43 (M=23.65, SD=2.70)	21-34 (M=23.15, SD=1.73)

Note: EFA=Exploratory factor analysis, CFA= Confirmatory factor analysis

**Table 2** Removed items

		Contents
F3	Q21	<i>I can usually get help quickly when I need some advice about using ICT devices</i>
F3	Q31	<i>I can usually get help quickly when I have an ICT device problem</i>
F3	Q34	<i>The ICT training I have received has helped me to use the ICT devices efficiently</i>
F4	Q9	<i>The time I spend with patients is reduced because of the time I spend at the ICT devices</i>
F4	Q14	<i>Use of electronic health records are more of a hindrance than a help to patient care</i>

Note: F3= Factor 3, F4 = Factor 4.

**Table 3** Exploratory factor analysis

Name of Factor		Item content	F1	F2	F3	F4	Ward (2006)
Care Value of ICT (Factor 1)	Q1	Using ICT devices is helping to improve patient/client care.	<b>.95</b>	.13	.00	-.08	S1
	Q2	The sort of information I can get from the ICT devices helps me give better care to patients	<b>.83</b>	.13	.01	.03	S1
	Q3	Using ICT devices makes my communication with other health professionals faster	<b>.55</b>	.12	.01	.03	S1
	Q5	I believe ICT devices can help us deliver individualised care.	<b>.50</b>	.05	.08	.05	S1
Training of ICT skills (Factor 2)	Q29	I feel I need more training to use the ICT devices properly	.00	<b>.89</b>	-.12	.02	S2
	Q27	I would like to have on-going training to help me improve my ICT skills	.04	<b>.77</b>	.00	.09	S2
	Q28	ICT skills are becoming more and more necessary for healthcare professionals	.13	<b>.73</b>	.09	.09	S2
	Q30	In order to be successful in my career I need to be able to work with ICT devices	.16	<b>.65</b>	-.01	.02	S2
	Q25	Using ICT devices helps to increase professionals' knowledge base	.06	<b>.63</b>	.19	-.13	S2
	Q22	I would like to know more about ICT devices generally	.12	<b>.50</b>	.02	.06	S2
ICT Confidence (Factor 3)	Q35	I lack confidence in my general ICT skills.	.07	-.11	<b>.79</b>	.05	S3
	Q39	I generally feel confident working with ICT devices.	.14	.07	<b>.70</b>	-.03	S3
	*Q19	I have all the general ICT skills I need for my job	-.05	-.01	<b>.70</b>	-.21	S2
	Q32	I am easily able to learn new ICT skills.	.05	.16	<b>.59</b>	.00	S2
	Q42	I'm often unsure what to do when using ICT devices.	.03	-.06	<b>.59</b>	.28	S3
	*Q47	I sometimes feel very intimidated by the thought of using ICT devices.	-.10	.09	<b>.54</b>	.28	S3
Workload value of ICT (Factor 4)	Q17	Using ICT devices is more trouble than it's worth	.00	.05	.00	<b>.77</b>	S1
	Q16	Where I work, ICT devices make staff less productive	.03	.14	.05	<b>.57</b>	S1
	Q15	I feel there are too many ICT devices around now	-.20	.14	.01	<b>.55</b>	S1
	Q10	I think we are in danger of letting ICT devices take over	.21	-.22	.03	<b>.53</b>	S1
	Q13	Time spent on ICT devices is out of proportion to its benefits	.10	.00	.00	<b>.53</b>	S1
Sums of Squared Loadings			4.4	3.1	2.0	1.6	
% of Variance			21.1	14.9	9.4	7.4	
Cumulative %			21.1	36.0	45.4	52.9	
Ordinal alpha			.86	.88	.83	.75	

Note: numbers in boldface =factor loadings higher than .40; asterisked items were omitted during the CFA process; F1-F4 = this study's pattern matrix factor loadings; S1-3= Scales 1-3 in Ward (2006)'s study of ITASH.

**Table 4** Fit statistics for each factor of the Korean version of Information Technology Attitude Scales for Health

		n*	$\chi^2$ (df)	p	$\chi^2$ /df	GFI	AGFI	NFI	IFI	CFI	RMR	RMSEA
CV		4	0.33(2)	.85	.17	1.00	1.00	1.00	1.00	1.00	.01	<.01
TR		6	3.05(9)	.96	.34	1.00	1.00	1.00	1.00	1.00	.03	<.01
CF	Pre	6	23.31(9)	.01	2.59	.99	.97	.97	.98	.98	.08	.10
	Post	4	0.25(2)	.87	.13	1.00	1.00	1.00	1.00	1.00	.01	<.01
WV		5	2.85(5)	.72	.57	1.00	.99	.99	1.00	1.00	.05	<.01
Total		19	135.74(146)	.72	.93	.98	.97	.96	1.00	1.00	.08	<.01

Note: CV = care value of ICT; TR = training of ICT skills; CF = ICT confidence; WV = workload value of ICT; Pre = before removing items via CFA; Post = after removing items via CFA; n\* = the number of items;  $\chi^2$  = chi-square; df = degree of freedom; GFI = goodness of fit index; AGFI = adjusted Goodness of fit index; NFI = normal fit index; IFI = incremental fit index; CFI = comparative fit index; RMR = root mean square residual; RMSEA = root mean square error of approximation.

**Table 5** Descriptive statistics for all factors of Information Technology Attitude Scales for Health

Factor	n	EFA (n=346)		CFA (n=162)	
		M	SD	M	SD
CV	4	3.35	.43	3.40	.41
TR	6	3.22	.39	3.30	.41
CF	4	2.77	.50	2.83	.50
WV	5	2.66	.43	2.91	.41

Note: n = the number of items; EFA = exploratory factor analysis; CFA = confirmatory factor analysis; CV = care value of ICT; TR = training of ICT skills; CF = ICT confidence; WV = workload value of ICT

**Table 6** Squared correlations between factors, construct reliability and average variance extracted

	CV	TR	CF	WV
CV	1.00			
TR	.40	1.00		
CF	.17	.14	1.00	
WV	.16	.14	.23	1.00
CR	.86	.91	.87	.84
AVE	.62	.62	.62	.52
$\alpha$	.85	.90	.84	.81

Note: CV = care value of ICT; TR = training of ICT skills; CF = ICT confidence; WV = workload value of ICT; CR = construct reliability; AVE = average variance extracted;  $\alpha$  = Ordinal alpha